Supporting Shared Care for Diabetes Patients

The Synapses Solution

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In this paper we discuss the construction of a Federated Health Care Record server within the context of the European R&D project Synapses. We describe the system using the five ODP viewpoints. From an analysis of the business process to be supported by the distributed system (the shared care for diabetes patients) requirements for the server are derived.

Introduction

The Synapses Project, partly funded under the EU Health Telematics Framework IV Programme, sets out to solve problems of sharing data between autonomous information systems, by providing generic and open means to combine HealthCare records or dossiers consistently, simply, comprehensibly and securely, whether the data passes within a single HealthCare institution or between institutions [1]. The approach taken in Synapses is to develop the specifications of a server acting as a mediator between information systems keeping parts of medical records (the so called feeder systems) and client applications, used for viewing the medical records.

Use will be made of existing results in standardization, like GEHR, CEN/TC251 (WG1/PT011), and CORBA. The fundamental enabling technologies for Synapses are open distributed computing, object orientation, browsing, information filtering, multimedia, security mediation and telecommunications. The project plans to bring those technologies together, apply them to HealthCare, and produce prototypes validating the server specification. The result will be in the public domain in the form of a set of specifications and guidelines for using them.

Currently, the electronic and paper records used by physicians and nurses are mostly held in isolated islands of information. Therefore, sharing information across systems and between carers is very difficult and time consuming. Often, non-automated and non-efficient means of communication are used for sharing information. This is hampering the progress towards shared care and cost-containment.

These problems are clearly illustrated by the case of providing shared care for diabetic patients. The treatment of diabetic patients involves the general practitioner, a nurse specialized in the treatment of diabetic patients and several health care providers at the outpatient clinic and various departments within the hospital. At the different stages of this process several flows of information occur between the health care providers involved.

HISCOM, the Academic Medical Center in Amsterdam, and two GP-groups in Amsterdam have set as objective within SYNAPSES to enable the sharing of the entities included in the DiabCare dataset between these health care providers. The DiabCare dataset is a set of data elements, agreed upon at an European level, encompassing all information relevant for monitoring therapy and secondary complications [2].

The Synapses server will provide a set of services for making the distributed character of the diabetes patient record and related data stored in the feeders transparent. The core of the server will be an Object dictionary structured according to a Common Object Model. The common object model ensures that the record components from the different feeder systems are interpreted in a coherent way.

The Synapses solution can thus be seen as the realization of a distributed health care record system, constructed out of different heterogeneous component systems. The Open Distributed Processing standards initiative

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[**ODP**, 3-6] defines five perspectives, called viewpoints, from which distributed systems can be described. These five viewpoints are:

- the *enterprise viewpoint* - is concerned with the business environment in which the system has to operate;
- the *information viewpoint* - is concerned with the information to be stored and processed by the system;
- the *computational viewpoint* - is concerned with a description of the system as a set of *objects* that interact at *interfaces*;
- the *engineering viewpoint* - is concerned with the mechanisms supporting system distribution;
- the *technology viewpoint* - is concerned with the detail of components from which the distributed system is constructed.

In this paper the Synapses server, as developed for supporting shared care for diabetes patients, is described from each of the five ODP viewpoints. We will start with a description from the enterprise viewpoint, and work from there all the way down to the technology viewpoint.

The Enterprise Viewpoint

The enterprise viewpoint describes the distributed system to be developed in the business environment in which it will operate. Main focus of such a description are the relations between the participants in the business process to be supported. Our model from this viewpoint will be illustrated by means of a small example, taken from the daily practice of providing shared care to diabetes patients. The model is presented in three steps:

1. First we describe a use-case [7], which is one of the specific business processes to be supported by the Synapses server.
2. Then we model the agents, the roles they play in the process and their relations, by means of an Import/Export diagram [8].
3. And finally, we indicate how their behaviors are restricted by their cooperation.[8]

The Use Case

Jacobson defines a use case as [7, p.105]:

> '...a sequence of transactions in a system whose task is to yield a result of measurable value to an individual actor of the system.'

In our case the actor (that is; the user of the business process) is the patient. The use case is described as:

Providing Care - A patient visits the General Practitioner (GP) complaining of increased thirst, frequent urination, blurred vision and great tiredness. The GP refers the patient to the Internist in the hospital. There the patient is diagnosed as suffering from insulin dependent diabetes, and an appropriate treatment is planned.

Agents, Roles, Resources and Relations

The figure below models Agents, Roles, Resources and their relations by means of an Import/Export diagram. Agents and resources are modeled as classes. Their roles as operations. An arrow between two classes indicates the usage of roles.

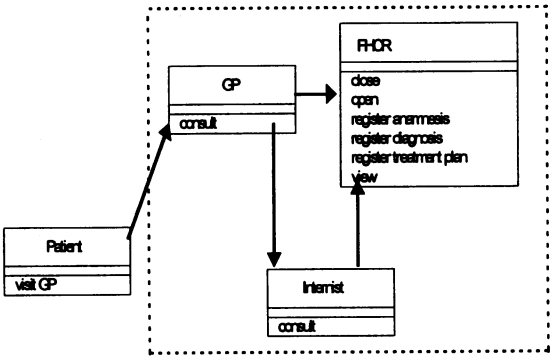

Figure 1: Import/Export-diagram

The classes inside the box make up the business process described in the use case above. The arrows point in the direction of a uses relation. So, the patient uses the role *consult* offered by the GP. The GP uses the role *consult* offered by the Internist. Both GP and Internist use roles from the resource Federated HealthCare Record (**FHCR**). The GP registers the results of the anamnesis, and the Internist registers the diagnosis and the treatment plan. Both *open* and *close* the FHCR when inserting or updating information in it, and both *view* information contained in it.

The behaviors and how they are restricted

We will illustrate this aspect of the enterprise viewpoint model by looking at a simple behavior restriction implied by the interaction structure presented in figure 1. In order not to make this discussion too lengthy, we will describe the restrictions in natural language. A formal approach, based on State Transition Diagrams, is presented in [9].

Both the GP and the Internist use the resource FHCR. As we will see in the next section on the information viewpoint, the *episode of care* is an important structuring element of the FHCR. It combines all information related to a specific problem for which a patient is treated. If the GP refers the patient to the Internist, the GP must register the results of the anamnesis and examination before the Internist can use the file for diagnosing and planning a treatment. The GP must indicate when the file is up to date. In the current situation the GP registers the necessary information in a referral letter that is sent to the Internist. An appointment with the Internist can only be scheduled after the referral letter is received by the Internist. This letter is filed in the paper based medical record kept in the hospital.

The Information Viewpoint

The enterprise viewpoint has made explicit which information is shared by the different health care providers participating in the process of shared care. In the information viewpoint we describe this information as an integrated model. This integrated model provides the uniform view of all health care providers involved on the diabetes record.

In the figure below a simplified version of the model is described as an object model, using the OMT notation [10]. The model of the FHCR is derived from the CEN standardization work on medical records architectures [11].

A RecordFolder (record of one patient) consists of one or more episodes of care. Each episode of care consists of one Episode_of_Care_Description and zero or more Episode_of_Care_Entries. An episode of care entry can be a diagnosis, an examination result, etceteras. Both description and entry inherit from the ENV 12265 class ComRIC, which represents the smallest meaningful, autonomous set of information.

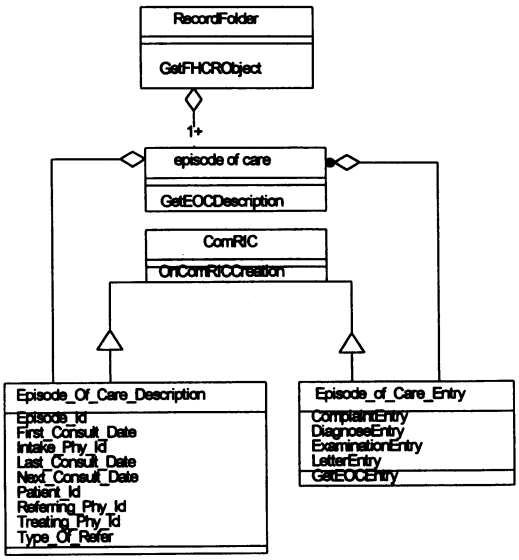

Figure 2: The object model of the Synapses server

The Computational Viewpoint

The integrated information model is distributed over the computational components making up the distributed system. We distinguish between three types of components: client applications, feeder systems and middleware components. The instances of these three types encountered in our pilot study are discussed below:

1. **Client application**: This component offers health care providers involved in the process of providing shared care for diabetic patients, a uniform view on the distributed patient record.
2. **Feeder system:** This component stores (parts of) the patient record.
3. **Synapses Server**: this middleware component is responsible for making the distributed character of the FHCR transparent to client applications. The view offered on the patient record must be compliant to the object model presented in the section on the information viewpoint.
4. **Client Adapter**: If non-synapses compliant client applications are used, information flows between the client application and

the synapses server must be syntactically and semantically converted. This is the function of the client adapter.

5. **Feeder Adapter**: Currently a number of information systems are in use for registering parts of the medical record. In our pilot study diabetes related information is stored in systems used by the general practitioners and in a hospital information system. These systems are not Synapses compliant. Their data is structured differently, they use different keys for patient identification, different security rules and different services for accessing the data. These differences are to be dealt with by the feeder adapters. These adapters wrap the feeders in such a way that they become Synapses compliant.

The components have well-defined interfaces. We have described these interfaces using OMG IDL [12].

The Engineering Viewpoint

The engineering viewpoint further details the computational viewpoint. It specifies how the computational components are connected using CORBA based integration solution. It is the last step in the specification before technologies and platforms can be selected for realizing the distributed system.

With regard to the client application and the feeder system components distinguished in the computational viewpoint, we also indicate which specific instances of these components will be chosen for the pilot study. So, the engineering viewpoint marks the transition from the generic Synapses solution to the specific pilot study.

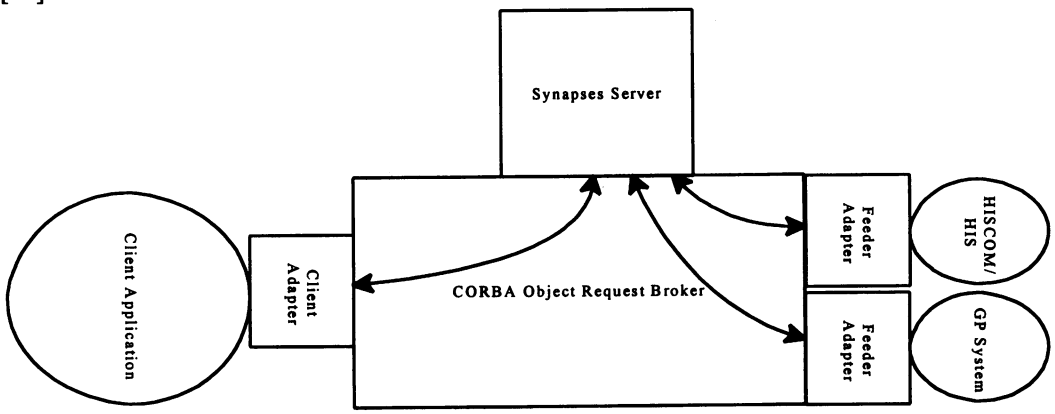

Figure 3: the engineering architecture for the Synapses solution

We have two instances of the feeder system component: a GP system and the HISCOM/HIS. They are wrapped by means of an adapter in order to make them Synapses compliant. Requests from the client application are translated in the client adapter and passed via the **O**bject **R**equest **B**roker (**ORB**) to the synapses server. Here the request is interpreted and translated into requests for the feeder systems. These requests are passed to the appropriate feeders via the ORB. Responses follow the same route in the opposite direction.

The Technology Viewpoint

The components distinguished in the engineering viewpoint are realized using several technologies and hardware platforms :

- ***Client application***: Each of the health care providers involved in the process of shared care for diabetes patients, has his own client application for accessing the patient record. Currently we envisage the use of two clients:
  - an application developed in Delphi, running on a pc under Windows95, already in use in the hospital

    - an application developed in Java, to be used by the GP
- ***The Synapses Server***: The server is developed in Visual C++ and runs on a pc under windows-nt 4.0
- ***The adapters:*** The adapters are also developed in Visual C++, and run on a pc under Windows-NT 4.0
- ***The ORB:*** For the CORBA Object Request Broker we have chosen ORBIX 2.0 from Iona ltd. This product offers an extensive implementation of the CORBA 2.0 specification. It uses a TCP/IP based network protocol for supporting communication.
- ***GP feeders:*** One of the GP feeder systems runs under Windows95 on a pc and the other GP feeder system runs under UNIX.
- ***HIS:*** The HISCOM HIS runs under UNIX.

Conclusion

The ODP viewpoints offer a good reference architecture for specifying distributed systems. It implies a five step approach. We started with an analysis of the business process to be supported by the distributed system we wanted to realize. This business process of providing shared care for diabetes patients was described in the enterprise viewpoint. It makes explicit which information is shared, at what moment and which restrictions apply. The enterprise viewpoint was only briefly illustrated here. For a more thorough discussion we refer to [9].

In the next step we derived from the enterprise viewpoint description an information model summarizing the information viewpoint shared by all health care providers involved in the business process. In the pilot study this information model described the patient record for diabetes patients.

We then distinguished the computational components needed for supporting an integrated view on the record for diabetes patients. These components were described as part of the computational viewpoint.

In the engineering viewpoint description we detailed thye computational viewpoint description by adding information on how the components were integrated and which instances of the computational components were used in our pilot study. We described how the CORBA ORB was used for integrating the components.

Finally, the specification was completed by indicating which technologies and hardware platforms were used for realizing the system described in the engineering viewpoint.

So, the analysis of the business process plays a pivotal role in the specification of the distributed system. It is the starting point from which all other specifications are derived. This is motivated by the fact that the distributed system to be constructed is an example of a Groupware or Computer Supported Cooperative Work application [13]. An important requirement for this approach to be successful is that the model of the business process is detailed enough.

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